86757

S/120/60/000/006/033/045
E032/E314

On the Rate of Growth and the Rate of Upward Drift of Bubbles
in a Propane Chamber

The errors indicated represent maximum deviations. According
to Plesset and Zwick (Ref. 4), the constant C for propane
has the theoretical value of 0.17. The rate of upward drift
for the above range of bubble radii was found to be 0.036
and 0.117 mm/sec. It is clear that the rate of upward drift
is appreciably greater than the rate of growth of the bubbles,
i.e. during its growth each bubble is displaced through the
surrounding medium. This fact was not taken into account by
Seitz (Ref. 3). The heat exchange between the bubble of
liquid, which determines its rate of growth, will be greater in
the case of a moving bubble. This will lead, in the case of
the present experiment, to a discrepancy between experiment
and theory, as indicated above. Further work is being carried
out in this connection.

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S/120/60/000/006/033/045
E032/E314

On the Rate of Growth and the Rate of Upward Drift of Bubbles
in a Propane Chamber

There are 1 figure and 4 references: 2 Soviet and 2 English.

ASSOCIATIONS: Fizicheskiy institut AN SSSR
                 (Physics Institute of the AS USSR)
                 Moskovskiy fiziko-tekhnicheskiy institut
                 (Moscow Physico-technical Institute)

SUBMITTED: September 29, 1959

Card 4/4

86756

21.5200 (1033, 1144, 1191)

AUTHORS: Aleksandrov, Yu.A., Delone, N.B., Likhachev, V.M.
and Gorbunkov, V.M.

TITLE: Formation of the Image in the Photography of
Bubble-chamber Tracks

TEXT: It was shown in Ref. 1 that when bubble-chamber tracks
are photographed, the object which is actually photographed is
the virtual image of the source in the bubbles. The
refractive index of the vapour in the bubble is smaller than
the refractive index of the surrounding liquid and hence the
bubble is divided into two zones. The bubble constitutes a
negative lens for rays incident at angles smaller than the
angle of the total internal reflection, and a convex spherical
mirror for rays incident at angles greater than the angle of
total internal reflection. This is illustrated in Fig. 1.
The point source S_o is located at infinity on the left of

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E032/E314

Formation of the Image in the Photography of Bubble-chamber Tracks

the bubble. The ray 1 is refracted, while the ray 2 is reflected. Intermediate rays having angles of incidence $i_1(i_2)$ have the corresponding values of $h_1(h_2)$ and $\varphi_1(\varphi_2)$. They form virtual images $S'_{01}(S'_{02})$ of the source S_o on the axis S_oO'. Both for the refracted and reflected rays we have

$$h_{1|(2)} = r \sin i_{1(2)}, \; h_{1(2)} = H_{1|(2)}$$

while for the refracted rays we have

$$\varphi_1 = 2(i'_1 - i_1) \quad \text{and} \quad n_{*} \sin i_1 = n_{\pi} \sin i'_1$$

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Formation of the Image in the Photography of Bubble-chamber Tracks

where $n_\ast$ is the refractive index of the liquid and

n_π is the refractive index of the vapour.

For the reflected rays $\varphi_2 = 2(90^\circ - i_2)$. The objective of the photographic camera receives a narrow pencil of rays whose aperture is defined by the diameter of the entrance pupil of the objective and the distance to the working volume of the camera. For an objective with a focal length of 50 mm, a relative power of 1:20 and a distance to the working volume of 500 mm, the aperture of the pencil is about 0.5 . It follows that the image formed by the objective is due only to a very narrow pencil of rays. Such a pencil will experience only paraxial aberrations, i.e. astigmatism and distortion. In order to confirm the above theory of image formation, an experiment was carried out using two sources of light located symmetrically with respect to the objective-bubble axis. In this geometry each bubble forms four virtual images, two of

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Formation of the Image in the Photography of Bubble-chamber
Tracks

which are produced by the refracting zone and two by the
reflecting zone. The distance between each corresponding
pair of images, which is equal to $2H_1$ and $2H_2$ in the two

cases, respectively, depends on the radius of the bubble.
For all bubbles, $2H_2$ is determined by the relative

refractive index of the liquid and the vapour $n_{\text{ж}}/n_{\pi}$.

In the experiment, an objective having a focal length of
240 mm and a relative power of 1:16 was employed. It was
found that the above theory describes the experimentally
obtained results to a high degree of accuracy.

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...rmation of the Image in the Photography of Bubble-chamber
...c ...
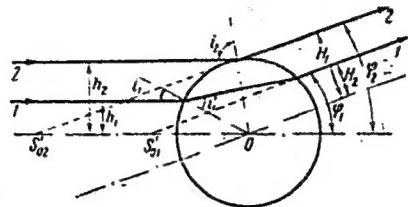
There are 2 figures and 1 Soviet reference.

ASSOCIATIONS: Fizicheskiy institut AN SSSR (Physics
Institute of the AS USSR) Moskovskiy fiziko-
tekhnicheskiy institut (Moscow Physico-
technical Institute)

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S/120/60/000/006/032/045
E032/E314

Formation of the Image in the Photography of Bubble-chamber
Tracks

SUBMITTED: September 29, 1959

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215200

S/120/60/000/01/034/051
E032/E314

AUTHORS: Aleksandrov, Yu.A., Gorbunkov, V.M., Delone, N.B. and Likhachev, V.M.

TITLE: On the Formation of Image in Bubble-chamber Track Photography

ABSTRACT: The bubbles which form the particle tracks in a bubble chamber are light scattering irregularities. They may be looked upon as spherical lenses having a refractive index which is different from that of the surrounding medium. The optical properties of such irregularities are determined by their relative refractive index and radius of curvature (Ref 1). In a bubble chamber, the refractive index of the liquid is greater than that of the bubble and, therefore, the latter behaves as a negative lens. The incident light is therefore refracted in the bubble and produces a virtual image of the source of light near the image of this "lens". Rays refracted by the lens and entering the objective of the photographic camera produce an image, not of the

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On the Formation of Image in Bubble-chamber Track Photography

bubble, but the virtual source which lies near the focus of the bubble. It is therefore of interest to consider the effect of the difference in the position of the bubbles and the corresponding images of the source of light. For paraxial rays incident from infinity the distance from the centre of the spherical lens of radius R to the image is given by:

$$f' = \frac{1}{2} Rn_2/\Delta n$$

where Δn is the difference between the refractive indices of the liquid and the bubble. Each point of the source of light is imaged near the focus of the spherical lens, and the entire source is imaged with a magnification given by $\beta \cong f'/L$ where L is the distance from the source of light to the bubble. Clearly, in the case of bubble chambers and particularly in the case of liquid-hydrogen bubble chambers in which Δn is small, the spatial separation of the bubbles and the images of the light sources will be very small. It has

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On the Formation of Image in Bubble-chamber Track Photography

been found with the aid of a model that aberration
and diffraction effects are negligible. A large-scale
photograph was taken of bubbles in a propane chamber
using the apparatus shown in Figure 1. The illuminating
system consists of a source of light S , an opaque
screen A and a diffuse reflector B . Figure 2 shows
photographs of electron tracks in the propane bubble
chamber. The electrons were due to Co^{60} sources.
In Figure 2, photograph (a) was obtained with a single
source (a small hole in a screen); (б) with two holes;
(B) with three holes; (в) and (д) with a ring source.
From a knowledge of the geometry of the experiment it
was possible to estimate the diameters of the bubbles.
They were found to be between Q1 and 0.4 mm, depending
on illumination conditions. It is concluded that the
recorded bubbles are in fact images of the source of
light. The spatial displacement of the image of the
source relative to the centre of the bubble is not small.
Thus, in the case of liquid hydrogen the quantity f' is

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S/120/60/000/01/034/051
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On the Formation of Image in Bubble-chamber Track Photography

approximately equal to 6R . Acknowledgment is made to
G.G. Slyusarev for valuable discussions.
There are 2 figures and 1 Soviet reference.

ASSOCIATION: Fizicheskiy institut AN SSSR (Physical Institute
of the Ac.Sc., USSR)

SUBMITTED: November 20, 1958

Card 4/4

BEILE, T.S.; GORBUNKOV, V.M.; ROZENBERG, L.D.

Calculating the amplification factor of a sound wave falling
obliquely on a parabolic mirror. Akust.zhur. 8 no.3:273-280 '62.
(MIRA 15:11)

1. Akusticheskiy institut AN SSSR, Moskva.
(Sound waves)

S/051/63/014/003/017/019
B032/B314

AUTHORS: Belonogov, A.V. and Gorbunkov, V.M.

TITLE: Measurement of the refractive index of liquid
               hydrogen

PERIODICAL: Optika i spektroskopiya, v.14, no.3, 1963, 438-440

TEXT: It is noted that a knowledge of the refractive index
of liquid hydrogen is of importance in the analysis of bubble-
chamber photographs. The authors describe the principle of a
device which may be used to determine the refractive index of
liquid parahydrogen and normal hydrogen (25% para- + 75% ortho-
hydrogen) in the equilibrium state at pressures of 1-9 atm to an
accuracy of better than $\pm 2 \cdot 10^{-4}$. It can also be used to determine
the difference in the refractive indexes of these two modifications
in a given container to better than $\pm 10^{-4}$. The device is based
on the fact that a plane-parallel plate (see figure) will displace
the point of convergence (A) of a homocentric beam by an amount $\triangle$
which is proportional to the thickness of the plate and its
refractive index. The object is a narrow slit 1 which is
illuminated by a monochromatic source 2.   It is imaged by a

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Measurement of the refractive ...   S/051/63/014/003/017/019
                                     E032/E514

lens 3 in such a way that the converging beams pass through an evacuated vessel with plane-parallel windows and then again through the same vessel filled with liquid hydrogen. In order to ensure the necessary accuracy of determining the displacement $\triangle$, two pairs of slits 4 and 4' are introduced symmetrically with respect to the lens 3 and define narrow beams. The latter are diffracted in such a way that two pairs of fringes are formed in the plane of the image of the slit. A small optical wedge 5 is used to displace one of the systems relative to the other. The image is observed through the microscope 6 with the container evacuated and filled with hydrogen. The refractive index n is then given by

$$n = \cos u \sqrt{\frac{t^2}{(t - \triangle)^2} + tg^2 u} \qquad (1)$$

where t is the thickness of the hydrogen layer, 2u is the angle between the axes of the diffracted beams in air and $\triangle$ is the measured displacement of the plane of the image. The device has been used to determine the refractive index as a function of density and temperature at $\lambda = 5460$ Å. The density dependence is
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Measurement of the refractive ...   S/051/63/014/003/017/019
                                      E032/E514

linear, while the temperature dependence is linear up to about
26°K and thereafter falls off more rapidly as the temperature
increases.   There are 4 figures.

SUBMITTED: September 28, 1962
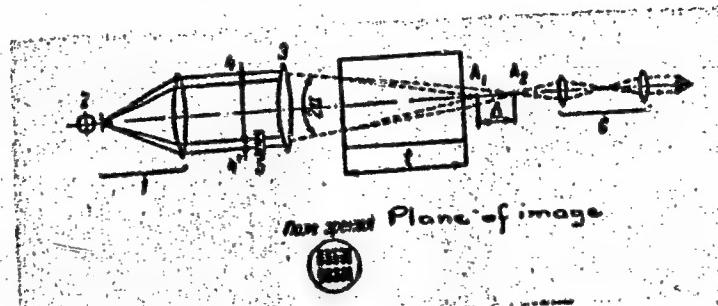
Fig.1

Card 3/3

ALEKSANDROV, Yu.A.; VORONOV, G.S.; GORBUNKOV, V.M.; DELONE,
        N.B.; NECHAYEV, Yu.I.; MATVEYEVA, A.V., red.; POPOVA,
        S.M., tekhn. red.

[Bubble chambers] Puzyr'kovye kamery. [By] IU.A.Aleksandrov
i dr. Moskva, Gosatomizdat, 1963. 339 p.   (MIRA 17:1)

L 24507-65   EWT(m)   IJP(c)/SSD/BSD/AFMD(c)/AEDC(a)/SSD(a)/AFWL/ASD(p)-3
AM4020390   BOOK EXPLOITATION   ASD(a)-5

Aleksandrov, Yu. A.; Voronov, G. S.; Gorbunkov, V. M.; Delone, N. B.; Nechayev,
Yu. I.

Bubble chambers (Puzyr'kovyye kamery*) Moscow, Gosatomizdat, 1963. 339 p.
    illus., biblio. Errata slip inserted. 3600 copies printed. Under the editor-
    ship of: Delone. N. B.; Editor: Matveyeva, A. V.; Technical editor: Poleva.
    S. N. Proofreader: Smirnov, M. A.

TOPIC TAGS: Bubble chamber, charged particle, track formation, track observation,
photofilm scattering, hydrogen refraction, superheated liquid, vapor bubbles.
hydrogen chamber

PURPOSE AND COVERAGE: The book represents the first attempt at a systematic ex-
position of the principles of the operation and the design of bubble chambers
and of their possibilities for the observation of particles. Special attention
is paid to the physics of the formation and the observation of tracks in the bubble
chamber, to generalization of separate data concerning the properties of the work-
ing medium, and to chamber design and future trends. V. I. Veksler directed the

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L 24507-65
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/ ?

authors' attention to the need for this compilation. The authors utilized the
work of specialists at the Ob"yedinennyy Institut Yadernykh Issledovaniy, the
Institut Teoreticheskoy i Eksperimental'noy Fiziki, the Fizicheskiy Institut
Akademii Nauk SSSR, and the Moskovskiy Inzhenerno-Fizicheskiy Institut. The
authors were aided directly by L. Bernshteyn (computing the scattering of
films), V. Morozov (checking the computations of the geometric theory of indica-
trices), E. Sviridenkov and J. Suchkov (obtaining data concerning the
indices of refraction . . . (programming and performing the cal-
culations).

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JM4020390

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L 24507-65
AM4020330

SUB CODE: NP   SUBMITTED: 24Sep63   NR REF SOV: 1.

OTHER: 255

Cord 4/4

L 12972-66   EWT(m)   IJP(c)

ACC NR: AP6000952   SOURCE CODE: UR/0286/65/000/022/0039/0039

AUTHORS: Galanin, M. D.; Gorbunkov, V. M.; Delone, N. B.; Korobkin, V. V.;
Leontovich, A. M.; Saitov, I. S.

ORG: none

TITLE: A method for illuminating particle tracks in chambers for the visual
observation of tracks. Class 21, No. 176332

SOURCE: Byulleten' izobreteniy i tovarnykh znakov, no. 22, 1965, 39

TOPIC TAGS: laser, particle track, coherent light

ABSTRACT: This Author Certificate presents a method for illuminating the particle
tracks in chambers for visual observation of tracks by pulsed light radiation. To
increase the accuracy of the physical experiment, an optical quantum generator (laser)
with confocal resonators is used for illuminating.

SUB CODE: 14/   SUBM DATE: 18Jun64

Card 1/1 HW   UDC: 621.375.8:539.1.073.8

L 64113-65   EWP(e)/EWT(m)/EWP(i)   WE,

ACCESSION NR: AP5021996   UR/0056/65/049/00

AUTHOR: Barkhudarova, T. M.; Voronov, G. S.; Gorbunkov, V. M.; Delone, N. B.

TITLE: Spatial distribution of the electrical field set up by a focused ruby laser beam

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 49, no. 2, 1965, 386-388

TOPIC TAGS: ruby laser, laser field, field distribution, spatial distribution, focused laser, laser output

ABSTRACT: The spatial distribution of the electric field set up by a Q-switched pulsed ruby laser was investigated. The laser consisted of standard ruby crystals 120 mm long and 10 mm in diameter. A spiral IFK-15000 lamp and ... used for pumping and Q-switching, respectively. The laser ... from several Mw to several tens of Mw. The beam was focused by lenses ... and 120 mm which were corrected for spherical abberation for ... ...

Card   1 2

L 64113-65

ACCESSION NR: AP5021096

the diffraction-distributed beam from individual ... the ... ... of the individual diffracti...

... ...

distribution of the ... between the lens and the laser, ...
if and increasing the ... the process is limited by the ...
trical fields can be attained. Further improvement of the field intensity can be achieved by
the focusing lens. Further improvement of the field intensity can be achieved by
reducing the number of resonator modes. Orig. art. has: 2 figures.

ASSOCIATION: ...

Institut ... ...

SUBMITTED: 24Feb65   ENCL: 00

NO REF SOV: 002   OTHER: 001   ATD PRESS: 4077

Card 2/2

L 1618-66   EWA(k)/FBD/EWT(1)/EWP(e)/EWT(m)/EEC(k)-2/EWP(i)/T/EWP(k)/EWA(m)-2/EWA(h)
SCTB/IJP(c)   WG/WH
ACCESSION NR: AP5023361

UR/0020/65/164/001/0075/0077
621.375.8:539.1.073.3

AUTHOR: Gorbunkov, V. M.; Korobkin, V. V.; Leontovich, A. M.

TITLE: Illumination of a bubble chamber by means of a ruby laser

SOURCE: AN SSSR. Doklady, v. 164, no. 1, 1965, 75-77 and top third of insert facing page 76

TOPIC TAGS: laser, ruby laser, laser illuminator, bubble chamber

ABSTRACT: A concentric-resonator ruby laser (λ = 6943 Å) was used to illuminate particle tracks in a bubble chamber. The experimental setup is shown in Fig. 1 of the Enclosure. The resonator consisted of dielectric-coated, concave spherical mirrors with a transmission of ~1% and 50-cm radii placed at a 100-cm distance. The ruby rod, 75 mm long and 9 mm in diameter, was pumped by 0.1-j pulses approximately 0.6 msec in duration from a 4-kj IFK-1500 flash lamp. The laser beam was uniformly distributed with an ~2° angular divergence which was magnified by an f = 50 mm lens to 20°. The experiments were carried out on a bubble chamber model consisting of a plane-parallel plate filled with air bubbles which corresponded to a 25 cm hydrogen bubble chamber described elsewhere (T. D. Blokhintseva, et al, Pribory i

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L 1618-66
ACCESSION NR: AP5023361

tekhnika eksperimenta, no. 5, 51, 1962). The test object T was placed 50 cm from the lens 0 and was illuminated by a concave spherical mirror M_0 (radius of curvature, 65 cm; diameter, 23 cm) placed 70 cm from 0. The laser-illuminated bubble tracks were photographed from a distance of ~50 cm with an $f = 53$ mm camera on a film with a 70 line/mm resolving power. The excess light was filtered by a combination of an interference filter at $\lambda = 694$ mμ with a 30% transmission and a neutral filter with an 11% transmission. The test object was photographed 5 times at different camera angles. The results indicate that the use of a laser illumination system without a filter makes it possible to record bubbles up to 0.06 mm in diameter in hydrogen. Small bubbles in larger chambers (e.g., Wilson's chamber) can be recorded at higher generation energies. Recording at reduced energies can also be effective in cases where low-sensitivity, high-resolution film is used for better contrast and accuracy. Orig. art. has: 1 formula and 2 figures.
[YK]

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Physics Institute, Academy of Sciences SSSR); Moskovskiy fiziko-tekhnicheskiy institut (Moscow Physicotechnical Institute)

SUBMITTED: 15Jan65	ENCL: 01	SUB CODE: EC,NP
NO REF SOV: 005	OTHER: 003	ATD PRESS: 4095
Card 2/3		

L 1618-66
ACCESSION NR: AP5023361   ENCLOSURE: 01
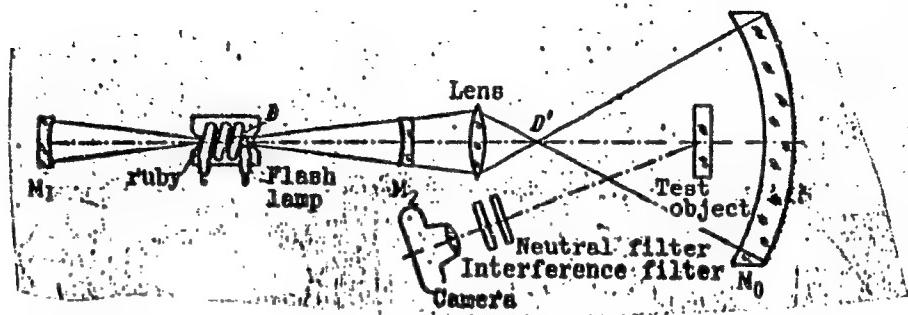
Fig. 1.   Diagram of systems for illumination and photography of bubbles

Card 3/3

GORBUNKOVA, L. A.

GORBUNKOVA, L. A.   "A case of elephantiasis of the vulva", Trudy Gnol. pos. med. in-ta, Vol. II, 1948, p. 327-29.

SO: U-4393, 19 August 53, (Letopis 'Zhurnal 'nykh Statey', No. 22, 1949).

GORBUNKOVA, Z. A.

GORBUNKOVA, Z. A.   "On the problem of the serous inflammation of the liver," Trudy Smol. gos. med. in-ta, Vol. II, 1948, p. 196-99.

SO: U-4393, 19 August 53, (Letopis 'Zhurnal 'nykh Statey', No. 22, 1949/

GORBUNKOVA, Z. A.

GORBUNKOVA, Z. A. and KROVKO, L. G.   "A case of acute pancreatitis of malarial origin," Trudy Smol. gos. med. in-ta, Vol. II, 1948, p. 337-39.

30: U-4393, 19 August 53, (Letopis 'Zhurnal 'nykh Statey', No. 22, 1949).

GORBUNKOVA, Z.A.

Soporific effect of oxygen therapy. Sov.med.18 no.1:13-15
Ja '54.   (MLRA 7:1)

1. Iz propedevticheskoy i fakul'tetskoy terapevticheskoy kliniki
Smolenskogo meditsinskogo instituta i kafedry patologicheskoy
fiziologii TSentral'nogo instituta usovershenstvovaniya vrachey.
                         (Oxygen--Therapeutic use)

GORBUNKOVA, Z.A., kand.med.nauk

Method of oxyhemometric investigations during oxygen therapy in
oxygen tents. Terap. arkh. 29 no.8:24-31 '58.   (MIRA 11:4)

1. Iz kliniki propedevtiki vnutrennikh bolezney (zav.-dotsent Z.A.
Gorbunkova) Smolenskogo meditsinskogo instituta.
          (OXYGEN, in blood,
                determ. in patients in oxygen tents & during oxygen
                ther. (Rus)

GORBUNKOVA, Z.A., dotsent

Method for preparing various oxygen concentrations for use in
oxygen tent therapy. Terap. arkh. 30 no.11:10-15 N '58 (MIRA 12:7)

1. Iz kafedry propedevtiki vnutrennikh bolezney Smolenskogo medit-
sinskogo instituta.
            (OXYGEN--THERAPEUTIC USE)

GORBUNKOVA, Z.A.

Oxyhemometry as a method for evaluating the effectiveness of oxygen
therapy in patients with chronic cardiopulmonary insufficiency.
Terap. arkh. 32 no. 4:63-72 S '60.   (MIRA 14:1)
            (PULMONARY HEART DISEASE)   (OXYGEN THERAPY)
                    (BLOOD—OXYGEN CONTENT)

GORBUNKOVA, Z.A., dotsent

Curves of oxygen saturation of the arterial blood and its
diagnostic significance in the evaluation of the effectiveness
of oxygen therapy in patients with arterial hypoxemia. Terap.
arkh. 33 no.4:31-42 '61.   (MIRA 14:5)

1. Iz kafedry propedevticheskoy terapii Smolenskogo meditsinskogo
instituta.
        (ANOXEMIA)   (OXYGEN THERAPY)

GORBUNOV, A.

Outlining an overall plan of sanitary measures.   Okh.truda.i sots.
strakh. no.1:70-71   Ja '60.   (MIRA 13:5)
       (MEDICINE, INDUSTRIAL)

GORBUNOV, A.

Be thrifty in dispensing vacancies for medical treatment. . Okhr.
truda i sots. strakh. 3 no.7:36-37 Jl '60.   (MIRA 13:8)
    (Ivanovo Province--Labor and laboring classes--Medical care)

MALYKHIN, V. (Leningrad); GORBUNOV, A. (Leningrad)

Fruit of a routine approach. Okhr.truda i sots.strakh. 5
no.12:27-28 D '62.   (MIRA 16:2)

1. Spetsial'nyye korrespondenty zhurnala "Okhrana truda i
sotsial'noye strakhovaniye".
                    (Leningrad—Medicine, Industrial)

GORBUNOV, A.

Is this the way to serve patients? Okhr. truda i sots. strakh. 4 no.3:25-26 Mr '61. (MIRA 14:3)

1. Spetsial'nyy korrespondent zhurnala "Okhrana truda i sotsial'-noye strakhovaniye" g. Pyatigorsk.
(Patigorsk—Health resorts, watering places, etc.)

GORBUNOV, A.

Along the path of continuous growth. Okhr. truda i sots.
strakh. 4 no.9:3-5 S '61.   (MIRA 14:10)
                    (Insurance, Social)

GORBUNOV, A.

Toward new milestones. Mest. prom. i khud. promys. 2 no.9:5 S '61.
(MIRA 14:11)

1. Direktor mozhginskoy fabriki "Krasnaya zvezda", g. Mozhga,
Udmurtskoy ASSR.
(Udmurt A.S.S.R.—Woodworking industries)

L'UNEVA, A., domokhozyayka; PLOTNIKOVA, A., lifter; YEGOROVA, N.;
    GANTSEV, M., slesar'-montazhnik; GORBUNOV, A.

In order to keep in a good mood. Zhil.-kom.khoz. 12 no.6:30-31
Je '62.   (MIRA 15:12)

1. Zaveduyushchaya priyemnym punktom "Akademgorodka" (for
Yegorova). 2. Vostoktekhmontazh (for Gantsev). 3. Direktor bani
i prachechnoy No.3 g. Novosibirsk (for Gorbunov).
            (Novosibirsk—Baths, Public)
            (Novosibirsk—Laundries, Public)

SALTYKOV, V., podpolkovnik; GORBUNOV, A., podpolkovnik

So firing in the mountains may be accurate. Voen.vest. 42
no.9:104-108 S '62. (MIRA 15:8)
(Artillery, Field and mountain) (Mountain warfare)

YEGORSHIN, N.A.; SHERSHEN', F.M.; SMIRNOV, A.N.; GORBUNOV, A.D.;
YEGOROV, V.P.; VASIL'YEV, A.V.; KOLOMEYTSEV, K.N.; KOLEGOV,
V.A.; KASATKINA, N.P., red.

[Mechanisms for lumbering camps; from work practices of the
construction office of the Chusovskoye Logging Camp] Mekhaniz-
my dlia lesozagotovok; iz opyta raboty konstruktorskogo biuro,
Chusovskogo lespromkhoza. Moskva, TSentr.nauchno-issl.in-t
informatsii i tekhniko-ekon.issledovanii po lesnoi, tselliu-
lozno-bumazhnoi, derevoobrabatyvaiushchei promyshl. i lesno-
mu khoz. 1963. 21 p. (MIRA 17:4)

GORBUNOV, A. D.

Mathematical Reviews
Vol. 14 No. 8
Sept. 1953
Analysis

Gorbunov, A. D. On a method for obtaining estimates of the solution of a system of ordinary linear homogeneous differential equations. Vestnik Moskov. Univ. Ser. Fiz.-Mat. Estest. Nauk 1950, no. 10, 19–26 (1950). (Russian)

Consider the system of linear homogeneous differential equations $dx/dt = E(t)x$ in which t is time, x is a real n-vector, and $E(t)$ is a square matrix of nth order, the elements of which are real, single-valued, and continuous functions of t in the interval $0 < t < \infty$. By the method of successive approximations one may obtain a bound for the components of the solution in any interval $0 < t < \tau$. But this bound goes to infinity as τ goes to infinity and therefore is not suitable for problems which are stable in the sense of Lyapunov. The object of this paper is the derivation of a formula which provides a bound more closely approximating the actual bounds for the case where x oscillates without increasing indefinitely. The author succeeds in finding a formula for such a bound provided it is possible to select a positive definite quadratic form in the n components of x which satisfies certain conditions.   W. T. Reid.

GORBUNOV, A. D.

Gorbunov, A. D. (Mathematics) Conditions of the monotonous stability of a system of common linear uniform differential equations. P. 15

Chair of Differential equations
Jan. 11, 1950

SO: Herald of the Moscow University (Vestnik), Series on Physical, Mathematical and Natural Sciences, No. 2, Vol. 6, No. 3, 1951

GORBUNCV, A. D.

A. D. Gorbunov. Certain solution properties of common linear systems of uniform differential equations. P. 3

Chair of Differential Equations, March 5, 1951

SO: Herald of the Moscow University, Series of Physics-Mathematics and Natural Sciences,
     No. 4; No. 6, 1951

GORBONOV, A. D.

GORBUNOV, A. D.   USSR/Mathematics - Differential Equations   Sep 53

"Conditions for Asymptotic Stability of the Null
Solution of a System of Ordinary Linear Homogeneous
Differential Equations," A. D. Gorbunov, Chair of
Diff Eq

Vest Mos Univ, Ser Fizikomat i Yest Nauk, No 6,
pp 49-55

The article considers conditions under which the
Lyapunov sufficiency conditions for asymptotic
stability can be transformed into necessary and
sufficient conditions for asymptotic stability of
the null solution. The following theorem is proved:

275T85

In order that the null solution of a system of the
type $\frac{dx}{dt} = L(t)x$ possess Lyapunov asymptotic stabil-
ity, it is necessary and sufficient that there exist
a positive definite quadratic form $G(t;x)$ with con-
tinuously differentiable coefs, such that the
conjugate quadratic form $g(t;x)$ relative to the
system $\frac{dx}{dt} = L(t)x$ is essentially negative in the
interval $-\infty < t < +\infty$ for which the integral
$\int_{t_o}^{\infty} N G(t)dt$ converges. Presented 18 Mar 53.

GORBUNOV, A.D.

Conditions of asymptotic stability in the zero method of solving simple li homogeneous differential equations. Vest.Mosk.un.8 no.9:49-55 S '53.

(MLRA 6:11)

1. Kafedra differentsial'nykh uravneniy. (Differential equations, Lin

GORBUNOV, A. D.

USSR/Mathematics - Differential equations   FD-668

Card 1/1   : Pub. 129 - 3/25

Author   : Gorbunov, A. D.

Title   : Evaluations of the coordinates of the solutions to systems of
                     ordinary linear differential equations

Periodical   : Vest. Mosk. un., Ser. fizikomat. i yest. nauk, Vol. 9, No. 5,
                     27-32, May 1954

Abstract   : Continues his earlier exposition (ibid. No. 12, 1952) of certain
                     properties possessed by the solutions to a system of ordinary
                     linear differential equations of the type $dy/dt = L(t)\,y + f(t)$,
                     where t is the independent real variable time, y is a matrix
                     column, $L(t)$ is a square matrix of the n-th order, and $f(t)$ is
                     a matrix column.

Institution   : Chair of Differential Equations

Submitted   : January 28, 1954

GORIDYOV

Certain problems in the qualitative theory of ordinary linear
uniform differential equations with variable coefficients.
Uch.zap.Mosk.un. 165:39-78 '54. (MLRA 8:2)
(Differential equations, Linear)

Gorbunov, A. D. Estimates of characteristic exponents of solutions of a system of ordinary linear homogeneous differential equations. Vestnik Moskov. Univ. 11 (1955), no. 2, 7–13. (Russian)

Given a homogeneous linear system (*) $x' = A(t)x$, $x = (x_1, \cdots, x_n)$, whose coefficients are real continuous bounded functions of t in $[0, +\infty)$, the author considers, in line with his previous paper [same Vestnik 1950, no. 10, 19–26; MR 14, 751], a quadratic form

$$G(t, x) = \sum A_{ih}(t) x_i x_h \quad (A_{ih} = A_{hi}),$$

which is positive definite for $t \geq 0$, and whose coefficients are continuous bounded real functions of t in $[0, +\infty)$. If $g(t, x)$ denotes the usual derivative of G written in terms of the system (*), and $n_G(\tau)$, $N_G(\tau)$ denote the minimum and the maximum of $g(\tau, x)$ for all real x with $G(\tau, x) = 1$, then the author proves the following estimates of the Lyapunov type numbers $\pi[x(t)]$ of the nontrivial solutions $x(t)$ of (*):

(a)
$$2\pi[x(t)] \geq \lim\sup t^{-1} \int_0^t n(\tau)d\tau,$$

(b)
$$2\pi[x(t)] \leq \pi[\omega] + \lim\sup t^{-1} \int_0^t N_G(\tau)d\tau,$$

where lim sup are taken as $t \to +\infty$, and $\omega(t)$ is the vector of the n principal minors of $A(t) = [A_{ih}]$ divided by the determinant of $A(t)$. Use is made of results of the quoted paper by the same author.   L. Cesari (Lafayette, Ind.).

GORBUNOV, A.D.; BUDAK, B.M.

Difference method for solving a nonlinear Goursat problem.
Vest. Mosk.un.Ser. mat. mekh. astron. fiz. khim. 12 no.4:3-8
'57.   (MIRA 11:5)
                 (Difference equations)

AUTHOR: BUDAK,B.M., GORBUNOV,A.D.   20-4-3/52

TITLE: On the Difference Method for the Solution of the Nonlinear
           Goursat Problem (O raznostnom metode resheniya nelineynoy
           zadachi Gursa).   SSSR/

ABSTRACT: The authors use the Difference method for the solution of the
           Goursat problem

$$u_{xy} = f(x,y,u,u_x,u_y),$$

$u(x,0) = \varphi(x); \quad 0 \leq x \leq l_x; \quad u(0,y) = \psi(y), \quad 0 < y \leq l_y; \quad \varphi(0) = \psi(0)$

for an arbitrary right side $f(x,y,u,u_x,u_y)$ which only in the
region of definition $0 \leq x \leq l_x, \quad 0 < y \leq l_y, \quad |u-u^0| \leq l_n,$

$|u_x - u_x^0| \leq l_{u_x}, \quad |u_y - u_y^0| \leq l_{u_y}$ is assumed to be continuous in all

arguments and in u, u_x, u_y it is assumed to be sufficiently

smooth. The functions $\varphi(x)$ and $\psi(y)$ are continuously differentiable
With the aid of a general criterion of convergence it is stated
that if f satisfies the Lipschits condition in u_x and u_y, then

Card 1/2

On the Difference Method for the Solution of the Nonlinear   20-4-3/52
Gonraat Problem

   the problem has a continuously differentiable solution. If
   the Lipschitz condition is satisfied also in u, then the
   solution is unique. For the case that f, $\varphi'(x)$ and $\psi'(y)$
   satisfy the Lipschitz condition in all arguments, the error
   is estimated by the steps in x and y and by the maximal values
   of the functions and their derivatives and by the Lipschitz
   constant. Finally the results are extended to a system of
   equations in the m-dimensional space.
   3 Soviet and 3 foreign references are quoted.

ASSOCIATION: Moscow State University im.M.V.Lomonosov (Moskovskiy
   gosudarstvennyy universitet im. M.V.Lomonosova)
PRESENTED: By S.L.Sobolev, Academician, 31 May 1957
SUBMITTED: 31 May 1957
AVAILABLE: Library of Congress
Card 2/2

AUTHORS: Budak, B.M., and Gorbunov, A.D.   SOV/55-58-1-2/33

TITLE: On the Convergence of Some Difference Methods for the Equations
          $y' = f(x,y)$ and $y'(x) = f[x,y(x),y(x-\tau(x))]$ (O skhodimosti
          nekotorykh konechno-raznostnykh protsessov dlya uravneniy
          $y' = f(x,y)$ i $y'(x) = f[x,y(x), y(x-\tau(x))]$)

PERIODICAL: Vestnik Moskovskogo universiteta, Seriya fiziko-matematicheskikh i
          yestestvennykh nauk, 1958, Nr 1, pp 23-32 (USSR)

ABSTRACT: Given the problem
          (1) $y' = f(x,y)$,
          (2) $y(x_0) = y_0$ $(x_0, y_0) \in G$.

          The approximate values y_i of y are obtained from the difference
          equation

          (3) $\sum_{i=0}^{m} \alpha_i y_{k-i} = h \sum_{i=0}^{n} \beta_i f_{k+1-i}$, $f_i = f(x_i, y_i)$, $x_i = x_0 + ih$,

          where the initial conditions are prescribed by
          (4) $y_i = g(x_i)$,

          where $g(x)$ is a continuously differentiable function changing with h.
          Furthermore the difference equation

Card 1/3

On the Convergence of Some Difference Methods for the   SOV/55-58-1-2/33
Equations $y' = f(x,y)$ and $y'(x) = f[x,y(x),y(x-\tau(x))]$

$$(5) \qquad \sum_{i=0}^{m-1} (\alpha_0 + \ldots + \alpha_i)\, \varphi(x_{k-i}) = h\,\psi(x_k)$$

is considered, where $\psi(x_k)$ is defined and finite in the points
x_k, $\|\psi\| = \max |\psi(x_k)|$. Let the solution of (5) be written in the
form $\varphi_k = hB_h \psi_k$, where B_h is a linear bounded operator,

$$\|B_h\| = \max_{0 \leq k \leq N_h} \sum_{i=0}^{h-1} |\gamma_{ki}|, \quad N_h = \left[\frac{x-x_0}{h}\right], \quad \gamma_{k_i} \text{ is determined by a}$$

fundamental solution of the homogeneous equation (5).
Theorem: Let the coefficients of (3) satisfy the conditions

$$\sum_{i=0}^{m} \alpha_i = 0, \quad \sum_{i=0}^{m-1} (\alpha_0 + \ldots + \alpha_i) = \sum_{i=0}^{n} \beta_i \neq 0.$$

For the uniform convergence of the difference process defined
by (3) it is necessary and sufficient that $\|B_h\|$ is uniformly
bounded in h, that the absolute values of the simple roots of

Card 2/3

On the Convergence of Some Difference Methods for the   SOV/55-58-1-2/33
Equations $y' = f(x,y)$ and $y'(x) = f[x,y(x),y(x-C(x))]$

$$\sum_{i=0}^{m-1} (\alpha_0 + \ldots + \alpha_1) \lambda^{m-1-i} = 0$$

are smaller or equal to one, and that the absolute values of the
multiple roots <1.
The exactness of the difference method is estimated.
There are 10 references, 7 of which are Soviet, 1 German, 1 Swedi
and 1 American.

ASSOCIATION: Kafedra matematiki dlya fisicheskogo f-ta i kafedra vychislitel'n
matematiki mekhaniko-matematicheskogo f-ta (Chair of Mathematics
of the Dept. of Physics and Chair of Numerical Mathematics of the
Dept. of Engineering Mathematics)

SUBMITTED: June 14, 1957

Card 3/3

A.D. Gorbunov

(2)

AUTHORS: Skorya, I.A., University Lecturer, and SOV/55-58-2-33/35
Kopylov, V.D., Scientific Assistant

TITLE: Lomonosov - Lectures 1957 at the Mechanical-Mathematical
Faculty of Moscow State University (Lomonosovskiye
chteniye 1957 goda na mekhaniko-matematicheskom fakul'tete
MGU)

PERIODICAL: Vestnik Moskovskogo Universiteta, Seriya matematiki, mekhaniki,
astronomii, fiziki, khimii, 1958, Nr 2, pp 241-246 (USSR)

ABSTRACT: The Lomonosov lectures 1957 took place from October 17 -
October 31, 1957 and were dedicated the 40-th anniversary
of the October revolution.

16. A.D. Gorbunov, Lecturer and B.M. Budak, Lecturer :
Difference Methods for the Solution of Hyperbolic
Equations.

17. N.S. Bakhvalov : Number of Calculation Operations for
the Solution of Elliptic Equations.

18. V.I. Lebedev, Aspirant : Difference Method for the
Solution of the Sobolev-System.

19. Professor Yu.V. Prokhin : Markov Processes and Semigroups.

20. A.G. Kostyuchenko, Candidate of Physical-Mathematical
Sciences : Decomposition of Differential Operators With
Respect to Generalized Eigenfunctions.

21. F.A. Berezin, Candidate of Physical-Mathematical Sciences:
Foundations of the Theory of Physical Spherical Harmonics on Mani-
folds.

22. V.M. Borok, Aspirant : General Properties of Partial
Evolution System.

23. V.A. Uspenskiy, Candidate of Physical-Mathematical
Sciences : On Constructive Mathematical Analysis.

24. P.L. Ul'yanov, Lecturer : Reversal of Terms in Trigono-
metric Series.

25. I.G. Petrovskiy, Academician and Ya.M. Landis, Senior
Scientific Assistant : On the Number of Boundary Cycles
of a Differential Equation of First Order With a Rational
Right Side.

The contents of all the lectures have already been published.

Card 2/3

16(1)
AUTHORS: Gorbunov, A.D. and Budak, B.M.   SOV/55-58-3-1/30

TITLE: The Method of Straight Lines for the Solution of a Non-Linear Boundary Value Problem in a Curvilinearly Bounded Domain (Metod pryamykh dlya resheniya odnoy nelineynoy krayevoy zadachi v oblasti s krivolineynoy granitsey)

PERIODICAL: Vestnik Moskovskogo universiteta, Seriya matematiki, mekhaniki, astronomii, fiziki, khimii, 1958, Nr 3 pp 3-12 (USSR)

ABSTRACT: The method of straight lines already applied for several times by the authors [Ref 1-3] is used in order to prove the existence, uniqueness and continuous dependence on the boundary conditions of the solution of the following boundary value problem : A continuously differentiable solution of the equation $u_{xy} = f(x,y,u,u_x,u_y)$ is to be found which satisfies the boundary conditions $u(x,g(x)) = \varphi(x)$, $0 \leqslant x \leqslant 1_x$; $u(0,y) = \psi(y)$, $0 \leqslant y \leqslant 1_y$. Here f is defined and continuous in $\bar{g}$: $0 \leqslant x \leqslant 1_x$, $g(x) \leqslant y \leqslant 1_y$, $|u| \leqslant 1_u$, $|u_x| \leqslant 1_{u_x}$, $|u_y| \leqslant 1_{u_y}$ and satisfies the Lipschitz conditions with respect to u_x and u_y ; $g'(x) \geqslant 0$ for

Card 1/2

The Method of Straight Lines for the Solution   SOV/55-58-3-1/30
of a Non-Linear Boundary Value Problem in a Curvilinearly Bounded Domain

$0 \leq x \leq l_x$, $g(0) = 0$, $g'(x)$ - continuous, $\varphi'(x)$, $\psi'(y)$ - con-
tinuous; the upper bounds of the absolute values of φ, φ'
etc. furthermore satisfy certain inequalities.
There are 3 Soviet references.

ASSOCIATION: Kafedra vychislitel'noy matematiki mekhaniko-matematiches-
kogo f-ta i kafedra matematiki fizicheskogo f-ta (Chair of
Computing Mathematics of the Mathematical-Mechanical Depart-
ment   and Chair of Mathematics of the Physical Department)

SUBMITTED: July 17, 1957

Card 2/2

16(1)
AUTHORS: Budak, B.M., and Gorbunov, A.D.   SOV/55-58-5-2/34

TITLE: On the Difference Method for the Solution of the Cauchy
             Problem for the Equation $y' = f(x,y)$ and for the System of
             Equations $x'_i = X_i(t,x_1,...,x_n)$, $i = 1,...,n$., With Dis-
             continuous Right Sides (O raznostnom metode resheniya zadachi
             Koshi dlya uravneniya $y' = f(x,y)$ i dlya sistemy uravneniy
             $x'_i = X_i(t,x_1,...,x_n)$, $i = 1,...,n$ s razryvnymi pravymi
             chastyami)

PERIODICAL: Vestnik Moskovskogo universiteta, Seriya matematiki, mekhaniki,
             astronomii, fiziki, khimii,   1958,Nr 5,pp 7 - 12 (USSR)

ABSTRACT: Let the Cauchy problem $y' = f(x,y)$, $y(x_0) = y_0$ be set up,
             where $f(x,y)$ is defined in $|x-x_0| \leqslant A$, $|y-y_0| \leqslant B$ and along
             certain singular curves suffers jumps in this rectangle, while
             it is uniformly continuous within each partial domain and
             satisfies the Lipschitz condition in y. The Eulerian polygonal
             curves are constructed and their convergence to the sought
             solution, the uniqueness of the solution and the continuous
             dependence of the solution on initial values and parameters

Card 1/2

On the Difference Method for the Solution of the $\quad$ SOV/55-58-5-2/34
Cauchy Problem for the Equation $y' = f(x,y)$ and for the System of
Equations $x'_i = X_i (t, x_1, \ldots, x_n)$, $i = 1, \ldots, n$, With Discontinuous Right
Sides

$\qquad$ is proved. The same results are obtained for the system of
equations mentioned in the title.
There is 1 Soviet reference.

ASSOCIATION: Kafedra matematiki fizicheskogo fakul'teta i vychislitel'noy
matematiki mekhaniko-matematicheskogo fakul'teta (Chair of
Mathematics of the Physical Department and Chair of Computing
Mathematics of the Mechanical-Matnematical Department)

SUBMITTED: June 23, 1958

Card 2/2

16(1) 16.3400   16.3900   16.6500   SOV/155-58-6-5/36

AUTHORS: Gorbunov, A.D., Budak, B.M.

TITLE: On the Difference Method for the Solution of the Cauchy Problem
for the System of Equations $x_i' = X_i(t,x_1,\ldots,x_n)$, $(i=1,\ldots,n)$
With Discontinuous Right Sides

PERIODICAL: Nauchnyye doklady vysshey shkoly. Fiziko-matematicheskiye nauki
1958, Nr 6, pp 25-29 (USSR)

ABSTRACT: The authors consider the Cauchy problem

$$(1) \quad x_i' = X_i(t,x_1,\ldots,x_n) \qquad i = 1,\ldots,n$$

$$(2) \quad x_i(t_o) = x_i^0 \qquad i = 1,\ldots,n$$

where the X_i can be discontinuous. They investigate existence-
and uniqueness theorems and the continuous dependence on the
initial conditions. The existence theorem is proved with the
aid of the Eulerian method of differences which is applied as
a homogeneous difference scheme ignoring the position of the
discontinuities. The velocity of convergence of the Eulerian

Card 1/2

68004

On the Difference Method for the Solution of the   SOV/155-58-6-5/36
Cauchy Problem for the System of Equations $x_i' = X_i(t, x_1, \ldots, x_n)$,1 = 1,..,n
With Discontinuous Right Sides

       polygones is investigated. Altogether three theorems are proved.

       There are 6 references, 5 of which are Soviet, and 1 Italian.

ASSOCIATION: Moskovskiy gosudarstvenny universitet imeni M.V. Loronosova
       (Moscow State University imeni M.V. Lomonosov)

SUBMITTED: September 17, 1958

Card 2/2

AUTHOR: Budak, B.M. and Gorbunov, A.D.   20-118-5-2/59

TITLE: Straight-Line Method for the Solution of a Non-linear
            Boundary Value Problem in a Domain With Curvilinear Boundary
            (Metod pryamykh dlya resheniya odnoy nelineynoy krayevoy za-
            dachi v oblasti s krivolineynoy granitsey)

ABSTRACT: The authors consider the equation

$$(1) \qquad u_{xy} = f\,(x,y,u,u_x,u_y)$$

in the domain

$$\bar{G} : \quad 0 \leq x \leq l_x \,,\ g(x) \leq y \leq l_y \,,\ |u| \leq l_u \,,\ |u_x| \leq l_{u_x} \,,\ |u_y| \leq l_{u_y} \,,$$

where $g(x) \geq 0$ for $0 < x \leq l_x$ and $g'(x) \geq 0$ is continuous.

It is assumed that f is continuous in $\bar{G}$ and satisfies the
Lipschitz condition with respect to u_x and u_y. A continuous-
ly differentiable solution is sought which satisfies the boun-
dary conditions

$$(2)\ \ u(x,g(x)) = \varphi(x) \quad,\ 0 \leq x \leq l_x \ ;\ u(0,y) = \psi(y) \quad 0 \leq y \leq l_y$$

Card 1/2

Straight-Line Method for the Solution of a Non-linear   20-118-5-2/59
Boundary Value Problem in a Domain With Curvilinear Boundary

where $\varphi'(x)$ and $\psi'(y)$ are continuous and $M_\varphi + 2M_\psi < l_u$,
$M_{\varphi'} + M_{\psi'}, M_{g'} < l_{u_x}$, $M_\psi < l_u$, $M_{\varphi'} < l_{u_y}$, where $M_\varphi, \ldots$ denotes
the upper bound of the modulus of φ, ...
Under these assumptions the existence of at least one solu-
tion is proved with the aid of the straight-line method. Un-
der additional conditions the uniqueness and continuous depen-
dence on the boundary conditions is shown and the error of
the approximative solution is estimated. There are 3 Soviet
references.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet imeni M.V.Lomonosova
(Moscow State University imeni M.V. Lomonosov)

PRESENTED: July 17,1957, by A.A. Dorodnitsyn, Academician

SUBMITTED: July 8,1957

Card 2/2

GORBUNOV, A.D.; BUDAK, B.M.

Stability of computation processes occurring in solving Cauchy's problem for the equation $dy/dx = f(x,y)$ by means of multiple-point difference methods. Vest. Mosk. un. Ser. mat., mekh., astron., fiz., khim. 14 no.2:15-23 '59   (MIRA 13:3)

1. Kafedry vychislitel'noy matematiki mekhaniko-matematicheskogo fakul'teta i matematiki fizicheskogo fakul'teta Moskovskogo gosuniver-siteta.
          (Differential equations)

AUTHOR: Gorbunov, A.D. and Budak, B.M. (Moscow)   20-119-4-5/59

TITLE: On the Convergence of Some Different Processes for the
Equations $y'=f(x,y)$ and $y'(x)=f(x,y(x),y(x-\tau(x)))$
(O skhodimosti nekotorykh konechnoraznostnykh protsessov dlya
uravneniy $y'=f(x,y)$ i $y'(x)=f(x,y(x),y(x-\tau(x)))$

PERIODICAL: Doklady Akademii Nauk SSSR, Vol 119, Nr 4, pp 644-647 (USSR)

ABSTRACT: Let the equation $y' = f(x,y)$ and the initial condition
$y(x_0) = y_0$, $(x_0,y_0) \in G$ be given. Let y_i denote the appro-
ximative value of the ordinate $y(x_i)$ of the solution in the
points $x_i = x_0 + ih$.
Theorem: If a difference process defined by the equation

$$\sum_{i=0}^{m} \alpha_i y_{k-i} = h \sum_{i=0}^{n} \beta_i f_{k+e-i} \quad , \quad f_j = f(x_j, y_j)$$

converges, then the following conditions are satisfied:

$$\sum_{i=0}^{m} \alpha_i = 0 \qquad \sum_{i=0}^{m-1} \sum_{j=0}^{i} \alpha_j = \sum_{i=0}^{n} \beta_i \neq 0$$

Card 1/2

SUBMITTED: October 26, 1957

16(1)
; AUTHORS: Budak, B.M. and Gorbunov, A.D.   SOV/20-124-6-3/55

TITLE: On the Stability of the Calculation Processes Arising in
             the Solution of the Cauchy Problem for the Equation $dy/dx=$
             $=f(x,y)$ With the Aid of Multipoint Difference Methods (Ob
             ustoychivosti vychislitel'nykh protsessov, voznikayushchikh
             pri reshenii mnogotochechnymi raznostnymi metod Koshi dlya uravneniya $dy/dx = f(x,y)$)

PERIODICAL: Doklady Akademii nauk SSSR,1959,Vol 124,Nr 6,pp 1191-1194(USSR)

ABSTRACT: The approximative solution of the problem

             (1) $y' = f(x,y)$,   (2) $y(x_0) = y_0$

             is sought by means of the difference equation

             (3) $\sum_{i=0}^{m} \alpha_i y_{k-i} = h \sum_{i=0}^{n} B_i f_{k+1-i}$, $f_j = f(x_j, y_j)$

             for the initial conditions

             (4) $y_0 = g(x_0,h)$, $y_1 = g(x_1,h)$.

             If K is the class of the admissible functions $f(x,y)$ and
Card 1/2   R(K) a certain method according to which the approximative

On the Stability of the Calculation Processes   SOV/20-124-6-3/55
Arising in the Solution of the Cauchy Problem for the Equation
dy/dx=f(x,y) With the Aid of Multipoint Difference Methods

solution y^* is found with the aid of (3) and (4), then
the totality (3),(4),R(K) is denoted as calculation pro-
cess which arises in the solution of (1)-(2) by means of
the difference method. In a very general way the "con-
vergence of the calculation process" and its "stability of
order k" is defined. In five theorems the relations
between (uniform) convergence, the stability of order
zero and one and the errors are formulated without proof.
There are 6 references, 5 of which are Soviet, and 1 is
Swedish.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet imeni M.V.Lomono-
sova (Moscow State University imeni M.V.Lomonosov)

PRESENTED: November 5, 1958, by S.L.Sobolev, Academician

SUBMITTED: November 3, 1958

Card 2/2

EUDAK, B.M.; GORBUNOV, A.D.

Many-point difference methods of solving Cauchy's problem for
the equation $y' = f(x, y)$. Vest.Mosk.un.Ser.1: Mat., mekh.
16 no.4:10-19 Jl-Ag '61.   (MIRA 14:8)

1. Kafedra matematiki fizicheskogo fakul'teta Moskovskogo
gosudarstvennogo universiteta.
        (Calculus, Differential) (Differential equations, Partial)

28659

_16.3400_   _16.3900_   _16.6500_ S/020/61/140/002/004/023
C111/C444

AUTHORS: Gorbunov, A. D., Budak, B. M.

TITLE: Multipoint difference methods for the solution of
Cauchy's problem in the case of the equation $y'=f(x,y)$

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 140, no. 2, 1961,
291-294

TEXT: The Cauchy problem

$$y' = f(x,y), \quad (x,y) \in G, \quad G \text{ a domain} \tag{1}$$

$$y(x_0) = y_0, \quad (x_0, y_0) \in G, \tag{2}$$

is to be solved approximatively by replacing it by the difference
problem

$$\sum_{i=0}^{m} \alpha_i y_{k+i} = h \sum_{i=0}^{n} \beta_i f(x_{k+i}, y_{k+i}), \quad x_j = x_0 + jh, \quad h > 0; \tag{3}$$

$$y_i \approx y(x_i), \quad i = 0, 1, \ldots, q - 1 \tag{4}$$

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where $q = \max(m,n)$ is the order of (3). Let $f(x,y)$ belong to the class
(A') if it is continuous in G and satisfies the Osgood condition in y.
Let $\delta_i = y(x_i) - y_i$. Definition: The difference method (3), (4) con-
verges unconditionally in the class (A'), if under arbitrary convergen-
ce to zero of $\max\limits_{0 \leq i \leq q-1} |\delta_i|$ for every $f(x,y) \in$ (A') an interval
$x_0 \leq x \leq \overline{x}_f$ exists such that $\delta_i \overrightarrow{} 0$ for $h \to 0$, $q \leq i \leq T_h$, where

$$T_h = \left[\frac{\overline{x}_f - x_0}{h}\right] - \frac{1}{2} \; \text{sign} \, (n-m) \cdot \left[1 + \text{sign} \, (n-m)\right].$$

Theorem 1: In order (3), (4) to converge unconditionally in (A') it is
necessary und sufficient that

$$\sum_{i=0}^{m} \alpha_i = 0, \qquad \sum_{i=0}^{m} i\alpha_i = \sum_{i=0}^{n} \beta_i \neq 0; \qquad (5)$$

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that all simple roots of the characteristic equation

$$\sum_{i=0}^{m-1} \sum_{j=i+1}^{m} \alpha_j \lambda^i = 0 \qquad (6)$$

have a modulus ≤ 1 and that all multiple roots of (6) have a modulus < 1.

If y_i^* is the approximative value of y_i obtained by round-off and if

$$Y'_k = \sum_{i=0}^{m} \alpha_i y_{k+i}^* - h \sum_{i=0}^{n} \beta_i f(x_{k+1}, y_{k+i})$$

then the stability of the computation process is secured, if the condition (7) $|\gamma|_k \leq O(h)$ for $h \to 0$ is satisfied (Theorem 2).

Let $f(x,y) \in (A'')$, if $f(x,y)$ satisfying the Osgood condition in both arguments. Let $D_k = y(x_k) - y_k^*$.

Theorem 3: If all roots of (6) have a modulus $< 1, f(x,y) \in (A'')$ and

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(5), (7) are satisfied, then outside of an arbitrary small neighborhood of $x = x_0$

$$\frac{\Delta D_k}{h} \rightrightarrows 0 \text{ for } h \to 0 \qquad (8)$$

for an arbitrary convergence to zero of $\max\limits_{0 \leqslant k \leqslant q-1} |D_k|$. If besides

$\Delta D_k / h \to 0$ for $h \to 0$, $k = 0, 1, \ldots, q - z$, then (8) holds for

$0 \leqslant k \leqslant T_n$. Theorem 4 brings estimations of $|D_k|$ for the case that

$f(x,y)$ in G satisfies the Lipschitz condition with respect to both arguments $(f(x,y) \in (B_0))$. Similar estimations for the case that the derivatives of $f(x,y)$ satisfy certain Lipschitz conditions are brought in theorem 5. In conclussion to theorem 4 and 5 in certain cases there follows the uniform estimation $|D_k| \leqslant O(h^s)$. In theorem 7 the special

equation (3)

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$$y_{k+m} = \sum_{i=0}^{m-1} \alpha_i y_{k+i} + h \sum_{i=0}^{m} \beta_i f(x_{k+i}, y_{k+i}),$$

where $f_y(x,y) \leqslant 0$, is considered. The theorems 8 and 9 contain a posteriori estimations. Let $\bar{\theta}(x) = \bar{y}'(x) - f(x,\bar{y}(x))$, where $y=\bar{y}(x)$ is the equation of the polygonal line which connects the points (x_i, y_i^{*}), $i = 0,1,\ldots$,. Let $D(x) = y(x) - \bar{y}(x)$,

$$F^{(1)}(x) = \left[f(x,y(x)) - f(x,\bar{y}(x))\right]\left[y(x) - \bar{y}(x)\right]^{-1},$$

$$\tilde{\theta}^{+}(x) = \begin{cases} \bar{\theta}(x) & \text{for } \bar{\theta}(x) \geqslant 0, \\ 0 & \text{for } \bar{\theta}(x) < 0, \end{cases} \qquad \bar{\theta}^{-}(x) = \begin{cases} 0 & \text{for } \bar{\theta}(x) \geqslant 0 \\ \bar{\theta}(x) & \text{for } \bar{\theta}(x) < 0 \end{cases}$$

Then it holds:

Theorem 8: For $D(x)$ there holds the estimation

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$$|D(x)| \leq |D(x_0)| \exp\left[\int_0^x F^{(D)}(\xi) d\xi\right] + \left|\int_{x_0}^x \bar{\theta}(\eta) \exp\left[\int_\eta^x F^{(D)}(\xi) d\xi\right] d\eta\right|. \quad (10)$$

There are 7 Soviet-bloc and 2 non-Soviet-bloc references.

The reference to English-language publication reads as follows: V. E. Miln, Chislennoye resheniye differentsial'nykh uravneniy, JL, 1955 [Numerical solution of differential equations] .

ASSOCIATION: Moskovskiy gosudarstvennyy universitet imeni M.V. Lomonosova (Moscow State University imeni M.V.Lomonosov)

PRESENTED: April 7, 1961, by S. L. Sobolev, Academician

SUBMITTED: April 7, 1961

Card 6/6

BUDAK, B.M.; GORBUNOV, A.D.

Multipoint method for solving Cauchy's problem for the equation
$y' = f(x,y)$. Vych. met. i prog. 1:19-46 '62.   (MIRA 15:8)
                        (Difference equations)

TIKHONOV, A.N. (Moskva); GORBUNOV, A.D. (Moskva)

Asymptotic error expansion in the difference method for solving
Cauchy's problem for a system of ordinary differential equations.
Zhur.vych.mat.i mat.fiz. 2 no.4:537-548 Jl-Ag '62. (MIRA 15:8)
     (Errors, Theory of)   (Differential equations)

TIKHONOV, A. N. (Moskva); GORBUNOV, A. D. (Moskva)

Optimality of implicit difference systems of the Adams type.
Zhur. vych. mat. i mat. fiz. 2 no.5:930-933 S-O '62.
(MIRA 16:1)

(Differential equations)

AUTHORS: Tikhonov, A. N., Gorbunov, A. D. (Moscow)

TITLE: Asymptotic estimates of error for a method of the Runge-Kutta type

PERIODICAL: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 3, no. 1, 1963, 195-197

TEXT: Approximate solutions of the Cauchy problem

$$dy/dx = f(x,y), \quad y(x_0) = y_0 \qquad (1)$$

by means of a formula of the Runge-Kutta type are considered. It is shown that the error satisfies the inequality

$$\|\delta_k\| \leq O(h^s) \left[\int_0^{x_k - x_0} \exp\{ NLd \} + O(h) \right],$$

if the function f is continuous and has continuous derivatives of the s-th order. Asymptotic expansions of the error are derived.

SUBMITTED: April 9, 1962
Card 1/1

L 12746-63   EWT(d)/FCC(w)/BDS   AFFTC   S/208/63/003/002/003/014
IJP(C)

AUTHOR: Gorbunov, A. D. (Moscow) and Shakhov, Yu. A. Tbilisi)

TITLE: An approximate solution of the Cauchy problem for ordinary differential
             equations with a preassigned number of exact signs. I

PERIODICAL: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 3, no.
             2, 1963, 239-253

TEXT: The bilateral difference method by Ronge-Cutt for the approximate
solution of the ordinary differential equations allows a simple and exact estimate
of errors and is easier than the similar method by Adams since it does not contain
the "initial section." The present paper investigates the abovementioned method
for the case of first order differential equations with an emphasis on the particu-
larities related to approximate quadratures (the approach follows three steps: the
evaluation of the quadratures, Cauchy's problem for one equation, and Cauchy's prob-
lem for a system of equations). The authors derive the bilateral methods for the
first, second, and third order. Each pair of equations depends on two parameters
whose choice specializes the method to suit any particular problem. Using the com-
puter Strela of the Moscow State University Computing Center, the authors numerical-
ly calculated tables for the functions (1) $y' = y$, $y(0) = 1$ with the third order
method; (2) $y' = -y/x$, $y(1) = 1$ with the second order method; (3) the Fresnel

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An approximate solution ......

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integral using the third order method with a limiting error of $6 \cdot 10^{-8}$ and (4)

$$\int_{0}^{8.95} dx/(1 + x)$$

with a preassigned accuracy and two exact signs. The authors

thank A. N. Tikhonov and I. S. Berezin for their interest. There are 7 tables.

SUBMITTED: May 19, 1962

Card 2/2

L 13054-65   EWT(d)   Pg-4   IJP(c)   MLK

ACCESSION NR: AT4047142   S/0000/64/000/000/0135/0148

AUTHOR: Gorbunov, A. D.(Moscow); Popov, V. N.(Moscow)

TITLE: Adams-type methods for an approximate solution of the Cauchy
problem for ordinary differential equations with delay

SOURCE: Chislenny*ye metody* resheniya differentsial'ny*kh i integral'-
ny*kh uravneniy i kvadraturny*ye formuly* (Numerical methods of solv-
ing differential and integral equations and quadrature into as
sbornik statev. Moscow, Izd-vo Nauka, 1964, 135-148

TOPIC TAGS: Cauchy problem, generalized Adams formula, differential
equation with delay, approximate method

ABSTRACT: This article deals with an approximate solution of the
Cauchy problem

$$\frac{dy(x)}{dx} = f\left(x, y(x), y(x-\tau(x))\right)$$

$$y(x) = \phi_0(x)$$

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ACCESSION NR: AT4047142

where f is a sufficiently smooth curve defined in a certain closed
domain of three-dimensional space, $\tau(x)$ (delay) is a given positive
and sufficiently smooth function, and $\phi_0(x)$ is a sufficiently smooth
function defined on a certain set of initial values. It is pointed
out that there is some possiblity that the approximate solution $y(x)$
has weak discontinuities (discontinuities of the first kind of its
derivative) and, therefore, "high accuracy" formulas of the Adams or
Runge-Kutta type can not be applied directly to the solution of this
problem, and certain modifications of these formulas are necessary.
Formulas for interpolating a function with discontinuous derivatives
are derived which serve as the basis for constructing generalized
formulas of the Adams type, and the algorithm of their application to
the solution of the given problem is presented. It is stressed that
the method developed can also be applied to the solution of Cauchy
lems for classical ordinary differential equations with discontinuous
right hand sides, for the neutral type of equations, and for other
analogous cases. The convergence of generalized methods of the Adams
type is proved, and an estimate of the computation error is established
The derived results are   extended to a system of equations. The
algorithms for solving the Cauchy problem for a system of equations

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with a delayed argument and for interpolating functions with dis-
continuous derivatives are written in ALGOL-60 language. Two numer-
ical examples illustrate the integration procedure. Orig. art has
Jt formulas.

ASSOCIATION: none

SUBMITTED: 20Apr63   ENCL: 00   SUB CODE: WI

NO REF SOV: 010   OTHER: 001   ATD PRESS: 3128

Card 3/3

ACCESSION NR: AP4024557

AUTHORS: Tikhonov, A. N. (Moscow); Gorbunov, A. D. (Moscow)

TITLE: Error estimate in Runga-Kutta method and optimum mesh selection

SOURCE: Zhurnal vy#chislitel'noy matematiki i matematicheskoy fiziki, v. 4, no. 2, 1964, 232-241

TOPIC TAGS: optimum mesh size, Runga-Kutta method, Cauchy problem, vector-function, asymptotic expansion

ABSTRACT: A method for selecting optimum mesh size in the Runga-Kutta method of solving the Cauchy problem has been discussed. The system of ordinary differential equations considered is represented by

$$\frac{dy}{dx} = f(x, y), \quad y(x_0) = y_0,$$

where f- is a given vector-function of N + 1 variables, smooth and continuously differentiable in a closed domain G. The functional distribution and various parameters of mesh size are introduced, forming an ensemble and representing an

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irregular array. An asymptotic expansion is obtained for the modulus of error, using the elements of irregular mesh representation. This is given by

$$v(x) = \lambda^n C \int_{x_0}^{x} \Xi(\xi, x)\bar{\psi}(\xi, y(\xi))\varphi^*(\xi)\,d\xi + O(\lambda^{n+1}),$$

where Ξ - matrizant of matrices $A(x)$; λ - positive number; φ - normal mesh size distribution function; ψ - a well-defined operator on f. Finally, the solution is given for selecting optimum mesh size. For N = 1, this is accomplished by minimizing the modulus of the principal term in the above equation for the error estimate. The mesh distribution function is then calculated, using an integration process. A similar method is used for N>1 by selecting some "preferable" coordinate or a "norm" of the principal term in the asymptotic expansion of the error modulus. Orig. art. has: 53 equations.

ASSOCIATION: none

SUBMITTED: 12Jul63   DATE ACQ: 16Apr64   ENCL: 00

SUB CODE: MM   NO REF SOV: 004   OTHER: 001
Card 2/2

ACCESSION NR: AP4037248   S/0208/64/004/003/0426/0433

AUTHORS: Gorbunov, A. D. (Moscow); Shakhov, Yu. A. (Tiflis)

TITLE: Approximate solution of the Cauchy problem for ordinary differential
equations with previously given number of correct signs. 2.

SOURCE: Zhurnal vy*chislitel'noy matematiki i matematicheskoy fiziki, v. 4, no. 3,
1964, 426-433

TOPIC TAGS: approximate solution, Cauchy problem, differential equation, correct
sign, Runge Kutta method

ABSTRACT: Let $y(x) = \{y^{(1)}(x),\ldots,y^{(N)}(x)\}$ be the desired vector-function, of N
dimensions, $f(x,y) = \{f^{(1)}(x,y),\ldots,f^{(N)}(x,y)\}$ be a given vector-function of N + 1
variables $x,y^{(1)},\ldots,y^{(N)}$, continuous and sufficiently smooth in some closed region
G of the space $\{x,y^{(1)},\ldots,y^{(N)}\}$, $(x_o,y_o) \in G$. The authors consider the Cauchy
problem for the system of differential equations.

$$\frac{dy}{dx} = f(x, y), \quad y(x_0) = y_0, \tag{1}$$

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ACCESSION NR: AP4037248

They describe coordinate-wise two-sided Runge-Kutta methods for approximate solution of (1) and give expressions for the remainder terms in the general case. They prove convergence of the Runge-Kutta methods, study the concept of measure of error of the approximate solution, and derive an effective estimate of the modulus of this measure. The conditions of computation under which the approximate solution is obtained with a given number of correct signs are explained, and some numerical results are given. This paper is a generalization of the authors' previous work (same title, No. I.). "The authors express their deep gratitude to A. N. Tikhonov, I. S. Berezin and D. A. Kveselav for their constant attention to the work." Orig. art. has: 4 tables and 20 formulas.

ASSOCIATION: none

SUBMITTED: 05Jun63   DATE ACQ: 09Jun64   ENCL: 00

SUB CODE: MA   NO REF SOV: 004   OTHER: 000

Card 2/2

BAKUSHINSKIY, A.B.; GAYSARYAN, S.S.; GORBUNOV, A.D.

"Numerical solution of ordinary and partial differential equations"
edited by L. Fox. Reviewed by A.B. Bakushinskii. Zhur. vych. mat.
i mat. fiz. 4 no.3:615-617 My-Je '64.   (MIRA 17:6)

GCRBUNOV, A.D. (Moskva); POPOV, V.N. (Moskva)

Adams type methods for approximate solution of the Cauchy problem for ordinary differential equations with retardation. Zhur. vych. mat. i mat. fiz. 4 no.4(suppl.):135-148 '64.

(MIRA 18:2)

$$y_{k+1} = y_k + h \sum_{i=0} \gamma_i f(x_{k+i}, y_{k+i}),$$

of the ... are ... numbers ... sum ...